

## CLAIMS

We claim:

Spall 1. An ejector ramjet engine suitable for use with a flying vehicle in a range of speeds from zero to hypersonic flight comprising:

an inlet with a variable inlet system attached to a mixer located downstream therefrom;

the mixer having an injector assembly mounted in the fluid flow zone of the mixer near the intersection with the inlet to form an ejector and a fluid supply system connected to the injector assembly wherein the injector assembly having a plurality of injector exhaust nozzles defined therein with the injector exhaust nozzles oriented to direct fluid release in the downstream flow direction partially offset from the engine longitudinal axis wherein the injector nozzles are offset radially at an angle away from and toward the engine longitudinal axis and the injector assembly supported in the mixer by a support element attached to an engine internal wall;

a diffuser having an expanding cross sectional area relative to the mixer attached downstream of the mixer;

a combustor having a larger cross sectional area relative to the mixer attached downstream of the diffuser and the fluid supply system connected to the combustor;

an exit nozzle having an expanding cross sectional area relative to the combustor attached downstream of the combustor with a choke constriction point intermediate the combustor and the exit nozzle.

2. The ejector ramjet engine as in claim 1 wherein the variable inlet control system comprising:

an actuator system to move an inlet fairing;

a second actuator system to move a flap in an internal inlet port;

a fixed isolator in which a shock train is contained by the actions of a downstream ejector, combustor and variable area exit nozzle;

the fixed isolator wherein the relative compression of the inlet is controlled by the inlet fairing actuator to maximize pressure recovery and airflow; and

the fixed isolator wherein the spill drag of the inlet may be controlled by the inlet flap actuator to minimize spill drag of the inlet.

3. The ejector ramjet engine as in claim 1 wherein the injector assembly comprising an injector ring having the injector exhaust nozzles therein.

4. The ejector ramjet engine as in claim 1 wherein the injector assembly comprising a plurality of radial struts having the injector exhaust nozzles therein.

5. The ejector ramjet engine as in claim 1 wherein the injector assembly comprising a plurality of radial struts with ring segments attached thereto having the injector exhaust nozzles therein.

6. The ejector ramjet engine as in claim 1 wherein the injector assembly comprising a combination of injector rings and radial struts having the injector exhaust nozzles therein.

7. The injector assembly as in claim 1 wherein the injector rings have slidable connections therein.

8. The injector assembly as in claim 1 wherein the exhaust nozzles are formed as a varying function opening relative to the radial distance from the longitudinal axis.

9. The ejector ramjet engine as in claim 1 wherein the fluid supply system connected to the injector assembly is an external gas generator.

10. The ejector ramjet engine as in claim 1 wherein the fluid supply system connected to the injector assembly is an injector combustor.

11. The ejector ramjet engine as in claim 1 wherein the fluid supply system connected to the injector assembly is a fuel and an oxidizer for combustion internal to the injector assembly.

12. The ejector ramjet engine as in claim 1 wherein adjacent injector exhaust nozzles are alternatively offset at an angle away from and toward respectively the engine longitudinal axis.

13. The ejector ramjet engine as in claim 1 wherein the injector combustor and the injector assembly use scramjet gaseous fuel in a subsonic and supersonic flow stream.

14. The ejector ramjet engine as in claim 1 wherein the exit nozzle has a movable plug mounted on a center body fairing for varying the choke constriction location.

15. The ejector ramjet engine as in claim 10 wherein the injector combustor is a ducted rocket hot gaseous source.

16. The ejector ramjet engine as in claim 1 wherein the ejector may function as a thrust augmentor at nominal ramjet and scramjet speeds to increase thrust while operating at high speed and altitude: (increasing fluid flow to the injector assembly to increase the ejector ramjet engine operating limits; and using a nominal to lean fuel to air ratio to cool the air between the mixer and the combustor.

17. The ejector ramjet engine as in claim 1 wherein a fluid may be injected into an exit nozzle divergent portion during low speed operation to initiate separation of exhaust in the exit nozzle and to control the location of the separation.

18. The ejector ramjet engine as in claim 1 wherein a fluid may be injected into an exit nozzle divergent portion during supersonic function of the exit nozzle to modify the location of the thrust vector.

19. The ejector ramjet engine as in claim 1 wherein: a fuel is injected into an air stream flow around the ejector ramjet engine through a piloting device; and a flame holding device maintains flame location and an injection device with a control valve controls the resultant force vectors caused by the combustion process.

20. An injector assembly suitable for mounting in the fluid flow path of jet engines such as turbojet, turbofan, turbo ramjet, turbo scramjet, supercharged ejector ramjet and the like as well as other gas flow paths such as in aircraft which use directed gas flow for vertical lift comprising:

an injector assembly having a plurality of injector exhaust nozzles defined therein;

the injector exhaust nozzles oriented to direct fluid release in the downstream flow direction partially offset radially at an angle away from and toward the fluid flow path longitudinal axis; and

the injector assembly supported in the fluid flow by a support element.

21. The injector assembly as in claim 20 wherein the injector exhaust nozzles are formed in an injector ring.

22. The injector assembly as in claim 20 wherein the injector exhaust nozzles are formed in a plurality of radial struts.

23. The injector assembly as in claim 20 wherein the injector exhaust nozzles are formed in a plurality of struts having ring segments attached thereto.

24. The injector assembly as in claim 20 wherein the injector exhaust nozzles

are formed in a combination of injector rings and radial struts.

25. The injector assembly as in claim 21 wherein the injector rings have a slidable connection therein.

26. The injector assembly as in claim 20 wherein the exhaust nozzles formed as a <sup>27</sup>varying function opening<sup>27</sup> relative to the radial distance from the longitudinal axis.

27. The injector assembly as in claim 20 wherein adjacent injector nozzles are alternatively offset at an angle away from and toward respectively the longitudinal axis.

<sup>28</sup>  
<sup>30</sup> 28 The ejector ramjet engine as in claim 1 wherein the fluid supply system further comprising a heat exchanger system for liquefaction of and storage of liquid air for use as an oxidizer in the injector assembly.

<sup>29</sup>  
<sup>31</sup> 29 The ejector ramjet engine as in claim <sup>30</sup> 30 wherein the heat exchanger system comprising:

an air liquefaction unit having an air inlet with an inlet port defined therein and the air inlet in fluid communication with a secondary precooler assembly and a primary precooler assembly;

a condenser in fluid communication with the primary precooler assembly and with a sump from which liquid air is pumped to a liquid air storage tank;

the liquid air storage tank having an outlet port to supply liquid air to the ejector ramjet engine;

the condenser having an inlet port for receipt of liquid hydrogen;

the condenser in fluid communication with the primary precooler assembly to transfer liquid hydrogen thereto and then to the secondary precooler having a liquid hydrogen exit port; and

the liquid hydrogen having a temperature differential relative to the air received by the air liquefaction unit sufficient to cool the air to be condensed to liquid air.

32. <sup>30</sup> The ejector ramjet engine as in claim <sup>29</sup> 31 wherein the air inlet having a humectant injection system.

33. <sup>31</sup> The ejector ramjet engine as in claim <sup>29</sup> 31 wherein the air inlet having a spray coolant system.

34. <sup>32</sup> The ejector ramjet engine as in claim <sup>29</sup> 31 wherein the air inlet having an air pump downstream of the inlet port.

35. <sup>33</sup> The ejector ramjet engine as in claim <sup>29</sup> 31 wherein a separator for removal of water and fluids other than liquid air is intermediate and in fluid communication with the secondary precooler and a primary precooler wherein the liquid hydrogen first passes through the primary precooler and then the secondary precooler.

36. <sup>34</sup> The device as in claim <sup>29</sup> 31 wherein there are a plurality of primary precoolers.

37. <sup>35</sup> The device as in claim <sup>29</sup> 31 wherein there are a plurality of secondary precoolers.